

CLAIMS

What is claimed is:

1. An apparatus for cleaning one or more surfaces within a vessel having a vessel wall separating a vessel exterior from a vessel interior and having a wall aperture, the apparatus comprising:
 - at least one elongate conduit having an upstream first end and a downstream second end and positioned to direct a shockwave from the second end into the vessel interior; and
 - a source of fuel and oxidizer coupled to the conduit to deliver the fuel and oxidizer to the conduit;
 - an initiator positioned to initiate a reaction of the fuel and oxidizer to produce the shockwave;
 - at least one sensor for sensing one or more thermodynamic properties associated with the vessel; and
 - a control system coupled to the initiator, the source, and the sensor for receiving input from the sensor and controlling operation of the initiator and source responsive to said input.
2. The apparatus of claim 1 wherein:
 - there are a plurality of such sensors including at least one temperature sensor and at least one pressure sensor.
3. The apparatus of claim 1 wherein:
 - there are a plurality of such sensors including at least one thermocouple positioned on the conduit or on the vessel and at least one infrared sensor.
4. The apparatus of claim 3 wherein:
 - the at least one infrared sensor includes an infrared camera.
5. The apparatus of claim 1 wherein:
 - there are a plurality of such sensors including at least one combustion emission sensor.
6. The apparatus of claim 1 wherein:
 - there are a plurality of such conduits and such initiators, each of the conduits associated with an associated one or more of the initiators; and

the control system includes:

a plurality of local controllers respectively associated with and so coupled to an associated one of the initiators; and

a central controller coupled to the plurality of local controllers .

7. The apparatus of claim 6 wherein:

the central controller is programmed to generate maintenance or service requests responsive to the input.

8. The apparatus of claim 1 wherein:

the control system communicates with a remote monitoring system.

9. The apparatus of claim 1 wherein:

the control system is programmed to control operation of the conduit responsive to input from the sensor.

10. The apparatus of claim 1 wherein:

the control system is programmed with a plurality of different cleaning processes and to execute the processes responsive to corresponding sensed conditions.

11. The apparatus of claim 1 further comprising:

an imaging inspection camera coupled to the control system for visual monitoring of the vessel interior.

12. A monitoring system for monitoring the operation of a plurality of remote detonative cleaning apparatus, the system comprising:

a communications interface for communicating with the apparatus;

a processor coupled to the communications interface; and

memory coupled to the processor, at least one of the processor and memory storing instructions for:

receiving data from the apparatus; and

recording information regarding the apparatus.

13. The system of claim 12 being a monitoring and control system wherein:

at least one of the processor and memory stores instructions for causing the apparatus to operate.

14. The system of claim 12 further including one or more displays.

15. The system of claim 14 wherein:

at least one of the one or more displays is connected to permit at least part time display of video camera input.

16. The system of claim 12 used in combination with a plurality of said apparatus, the plurality of said apparatus comprising:

a plurality of systems, each comprising:

a plurality of combustion conduits;

a plurality of local control modules, each associated with a give single one of the combustion conduits;

a fuel and oxidizer source coupled to the combustion conduits; and

a common control system coupled to the plurality of local control modules, and configured to provide said data to the monitoring system.

17. A method for cleaning surfaces within a plurality of vessels at a plurality of locations, the method comprising:

at a central location, monitoring data regarding each of the vessels; and

responsive to said monitored data for a particular one of the vessels, causing a detonative cleaning apparatus associated with the particular vessel to discharge to clean the surface within the particular vessel.

18. The method of claim 17 performed via a programmed control and monitoring system and that is programmed to select, responsive to said monitored data, at least one of a plurality of at least partially predetermined cleaning protocols and to cause said discharge according to the selected at least one protocol.

19. The method of claim 17 performed in a repeated sequential way.

20. The method of claim 17 further comprising:

using an infrared camera within each vessel to inspect the associated surface while the vessel is in operation.

21. The method of claim 17 wherein said monitoring comprises at least one of:
monitoring a surface emissivity within each of the vessels;
monitoring quantities of one or more chemical species in each of the vessels; and
monitoring one or more images of interiors of each of the vessels.
22. The method of claim 17 further comprising:
receiving an automated maintenance or service request for at least one of the vessels.